

Constellation Energy (Exelon)  
partnered with  
Oak Ridge National Laboratory

NE-21-25133, Advanced Nuclear Fuel Pellet Designs

**YEAR AWARDED:** 2021

**TOTAL PROJECT VALUE:** \$500k (DOE: \$400k, Constellation: \$100k)

**STATUS:** Completed

**PRINCIPAL LAB INVESTIGATORS:** Mehdi Asgari (ORNL), James Tusar (Constellation)

**DESCRIPTION:** Exelon Nuclear, now Constellation, operates the largest U.S. fleet of nuclear plants. In the pursuit of improving the operational, safety, and economic performance of existing power plants, the company engaged with Oak Ridge National Laboratory to evaluate and assess the feasibility and impact of various conceptual advanced nuclear fuel pellet designs (ANFPDs). In the effort pursued through this GAIN voucher, various accident-tolerant fuel and intricate design concepts were identified and evaluated to assess the viability, performance, and benefits of such fuel design concepts. This involved detailed modeling and simulation analysis of complex designs requiring access to advanced M&S environments. The Virtual Environment for Reactor Applications (VERA), which can simulate the operation of an entire reactor down to the characteristics of a single fuel rod was utilized to study advanced nuclear fuel pellet designs.

**BENEFIT:** The proprietary report presents a list of advanced fuel design concepts. All have been evaluated, with detailed analyses performed concerning feasibility, benefits, and potential opportunities.

**IMPACT:** DOE's advanced modeling and simulation capabilities were utilized to perform a series of coupled neutronic/thermal hydraulic and fuel performance calculations to better understand performance and benefits of such advanced fuel design concepts in terms of fuel cycle costs, operational safety, and margin improvement.

**SIGNIFICANT CONCLUSIONS:** Numerous nuclear fuel pellet design concepts were selected and analyzed using the advanced modeling and simulation capabilities of VERA/BISON, developed by DOE, to determine viability and fuel cycle benefits. Understanding the advantages of loading these fuel designs into the core is important not only to Constellation but to the entire fleet and nuclear fuel vendors.

**NEXT STEPS:** Constellation has set a goal to achieve 100 percent carbon-free power generation by 2040 by leveraging innovative technology and enhancing its diverse mix of hydro, wind and solar resources paired with its nuclear fleet. Future R&D with a goal of deploying advanced fuel pellet designs will leverage the conclusions from this project.